MISSOURI DEPARTMENT OF NATURAL RESOURCES

CLEANUP LEVELS FOR MISSOURI (CALM) Appendix F

Ecological Risk Assessment

Division of Air and Land Protection
Hazardous Waste Program

Revised September, 1998

CLEANUP LEVELS FOR MISSOURI (CALM)

APPENDIX F - ECOLOGICAL RISK ASSESSMENT

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1. INTRODUCTION

Many definitions exist for ecological risk assessment (e.g., U.S. EPA 1992; WERF 1993; SETAC 1987; Suter 1993). The U.S. EPA has defined ecological risk assessment (1992) as "a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors." To help assess these and other ecological concerns, the U.S. EPA (1992) has developed a framework for ecological risk assessment (Figure F1), and it is the application of this framework on a site-specific basis that governs the investigative process for ecological risk assessment (ERA) at a site. Figure F1 has been provided to enable the user to visualize where the qualitative ecological exposure assessment fits in the ERA process.

This appendix is intended to provide guidance for conducting an ecological risk assessment at a site being addressed through the CALM process. Two types of ecological risk assessments are discussed in this appendix: a qualitative exposure assessment, which is required at all sites, regardless of the tier under which the site is being addressed; and a quantitative ecological risk assessment, which is required only when the qualitative assessment suggests that ecological receptors present at a site may be exposed to and affected by contaminants in one or more media at a site. If the user determines via a qualitative ecological exposure assessment that ecological receptors may be at risk from contaminants at a site, a quantitative assessment may be required under Tier 2 or Tier 3 of the CALM process.

Section 2 of this appendix provides a detailed explanation of how a qualitative ecological exposure assessment should be conducted. Section 7 of this appendix briefly discusses quantitative ecological risk assessments.

2. QUALITATIVE ECOLOGICAL EXPOSURE ASSESSMENT

A qualitative ecological exposure assessment must be carried out as part of the initial site assessment for all sites being addressed under the CALM process. If the Phase I portion (see section 2.4) of the qualitative ecological exposure assessment indicates that ecological receptors may be at risk of exposure, or that populations of ecological receptors have been significantly reduced or extirpated at the site, the user should proceed to Phase II of the process.

2.1 Purpose

The purpose of a qualitative ecological exposure assessment is to provide the user with a process for determining whether the site is likely to pose a risk to ecological receptors. This assessment also can be used as a screening tool to determine whether a quantitative ecological risk assessment (ERA) is warranted. The exposure assessment poses a series

of questions that are designed to help the user determine whether a site is likely or unlikely to pose an ecological risk. These questions should be asked and answered before conducting a quantitative ERA. This assessment will complement, rather than dictate or supersede, pertinent federal, regional, or state regulations, and should help the user gather site ecological information to facilitate discussions with appropriate agencies.

The exposure assessment process addresses five categories of information that the user should consider:

1. The type of ecological risk assessment the information gathered in this process may ultimately serve;
2. Suggestions on how to plan the exposure analysis to serve multiple levels of ERA guidance or regulations at a future stage, if needed, including a partial listing of guidance documents;
3. Suggestions on how to address the question "Are there actual or potential ecological receptors present?";
4. Suggestions on how to address the question "Are there potential exposures to ecological receptors?";
5. Considerations for a scientific/management decision point (SMDP), as well as factors in the determination of further actions.

2.2 Approach

The exposure assessment process is not intended to recommend a single course of action; rather, it provides guidance at a qualitative level that will facilitate the decision of whether to proceed with a quantitative ecological risk assessment. The approach for conducting a qualitative ecological exposure assessment is illustrated in Figure F1. The qualitative ecological exposure assessment discussed in this appendix involves only the portion of Figure F1 that lies above the dashed line. The activities shown below the line are steps that are beyond the scope of this assessment but may need to be considered within the context of an overall tiered CALM process.

Typically, the qualitative ecological exposure assessment process will occur as part of the CALM initial site assessment. The assessment is divided into two phases: Phase I involves determining if there are actual or potential ecological receptors on or near the site or if specific ecological receptors are expected at or near the site, and Phase II addresses whether there is a potential for receptor exposure to these contaminants. If either of these conditions does not exist, there may be no need to proceed further except to document the findings. If remediation is contemplated for the site to reduce human health risks or to meet a cleanup goal, consideration should be given in the qualitative ecological exposure assessment to whether such action could affect ecological receptors.

For example, remediation activities could result in a release of contaminants, resulting in a completed exposure pathway where one previously did not exist.

If there are actual or potential ecological receptors at, near, or down gradient of the site, and if a potential exposure pathway exists, or if evidence suggests that populations of ecological receptors have been significantly reduced or extirpated at or near the site, then ecological issues may need to be considered as part of a quantitative ERA. This appendix provides guidance on how to collect information that will enable users to determine whether more detailed quantitative assessments are needed. Before the qualitative ecological exposure assessment process is examined in detail, it is worthwhile to survey the types of organizations and guidance that currently exist, as the nature of this guidance can influence the conduct of the qualitative ecological exposure assessment.

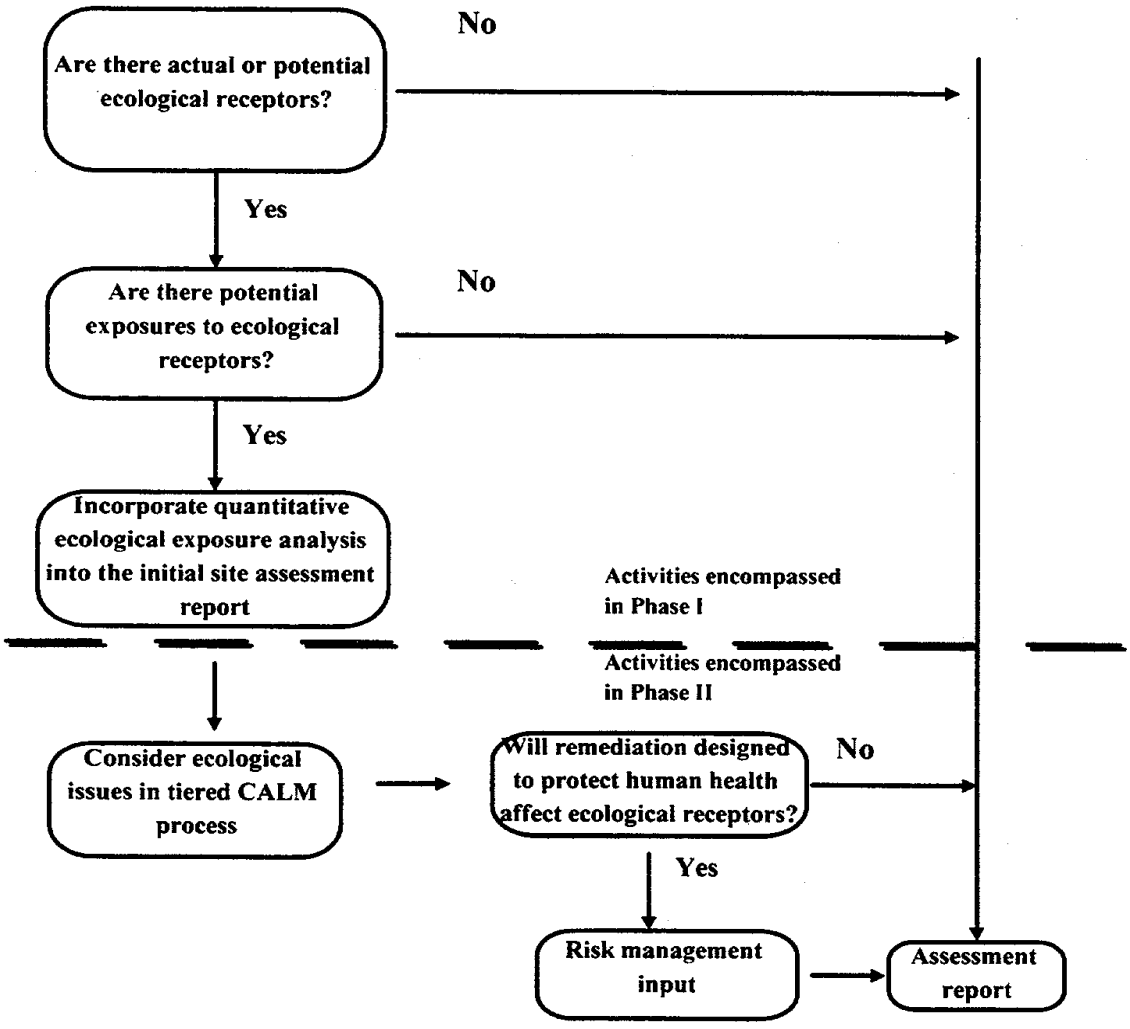

Figure F1

2.3 Existing Practices and Guidance

It is essential to the success of the qualitative ecological exposure assessment to have a clear understanding and a working knowledge of any existing practices and guidance that may influence the decision making process at the site under investigation. Without this understanding, the information gathered may not be sufficient to make a determination of "no completed exposure pathways" to ecological receptors. It is therefore recommended that the user consult with the appropriate state or EPA regional guidance documents and personnel.

Guidance for ERA is an evolving process at the federal, state, regional, and program levels. These sources may provide guidance for screening level assessments that will ultimately satisfy the department. Various programs within the department may also have specific guidance. For example, the Water Pollution Control Program has biota indicators to assist with assessing the extent and impact of water pollution. Also, the Department of Conservation has specific guidance for conducting risk assessments in Missouri's natural fisheries.

2.4 Phase I: Screening for Actual or Potential Ecological Receptors.

A. Discussion

Activities in Phase I will help the risk manager decide whether potential or actual ecological receptors are present, or are expected to be present, at or near the site. If receptors or habitat are present, or if ecological receptors are conspicuously absent from the site, then the risk manager should continue to Phase II (Section 2.5) on exposure pathways. If not, then no further action is required and the results should be documented in a CALM Report. Activities in this phase may also help the risk manager decide if initial response actions are warranted.

To check for potential receptors and habitat, a number of physical and biological site characteristics need to be considered. Tables F1, F2, and F3 were compiled to assist in this activity. These tables are intended to serve only to increase the user's awareness of what characteristics might need to be considered at the site before completing this section of the assessment, and is not a substitute for the checklist provided in Figure F2. The site inspection and biological site characterization sections below are presented to help identify receptors and habitat that may be potentially impacted due to a contaminant release.

Technical expertise is required to integrate the information considered in Tables F1 through F3 into the screening checklist provided in Figure F2, and because of the diversity of expertise needed in a site inspection or characterization, several technical disciplines may be required to address specific issues. For example, hydrogeologists might be necessary to advise on likely movement of contaminants through soil and groundwater. Remediation engineers might best advise on the feasibility of remedial actions and their effectiveness in reducing contaminant levels. Wildlife (aquatic and terrestrial) specialists may be needed to identify locally important species and determine if suitable habitat exists on a site.

B. Site Inspection

A physical characterization of the site should be conducted barring any human health and safety concerns. An accurate physical description of the site should be obtained and may include the following information:

1. The surface area of the site (acres, hectares, square miles, square feet) and its present use (heavy industrial, light industrial, urban, residential, rural);
2. The land use surrounding the site;
3. The topography of the site;
4. Any sensitive environments on or adjacent to the site (see text box on pg. F6 for examples of sensitive environments);
5. Previous soil disturbance on the site (e.g., erosion, agriculture, mining, soil moving equipment, natural events, etc.);
6. Evident signs of a contaminant release (odor, sheen, slick, etc.);
7. Percentage of the site that is terrestrial, aquatic, and wetland (use Tables F1, F2, and F3 to evaluate in greater detail wetland, aquatic and terrestrial habitats, respectively);
8. Accurate site maps showing structures, sampling locations, etc.;
9. Past uses of the site; and
10. Regional and local geologic and hydrologic information.

Examples of Environmentally Sensitive Areas
▸ National and State Parks ▸ Designated and proposed Federal and State Wilderness and Natural Areas ▸ Endangered or threatened species habitat as identified by the US Fish and Wildlife Service or the Missouri Department of Conservation ▸ National Monuments ▸ National and State Historical Sites ▸ National and State Lake Shore and River Recreational Areas ▸ Federal or State designated or proposed endangered or threatened species or species under review as to their endangered or threatened status ▸ National and State Preserves and Forests ▸ National and State Wildlife Refuges ▸ Spawning areas critical for the maintenance of fish/shellfish species within river or lake waters ▸ Migratory pathways and feeding areas critical for maintenance of anadromous fish species within river reaches or areas in lakes in which such fish spend extended periods of time ▸ Terrestrial areas utilized for breeding by large or dense aggregations of animals ▸ State of Federally designated Scenic or Wild Rivers ▸ State lands designated for wildlife or game management ▸ Wetlands

C. Biological Site Characterization

Biological site characterization involves describing the environs of the site and addresses the question: *"What is to be protected?"* This section is not intended to parallel the checklist shown in Figure F3, but rather serves as guidance as to what issues may need to be considered in the exposure analysis phase of the initial site assessment. This characterization should include, but is not limited to, the items described below.

1. List of natural communities represented at the site. (For more information on characterizing natural communities, see The terrestrial natural

communities of Missouri, Nelson, Paul W., Jefferson City, 1987.)

2. Aquatic: Pond, lake, impoundment, stream, river, estuary, vernal pool.
3. Terrestrial: Wooded, shrub/scrub, open grassland, agricultural, cave.
4. Wetland: Riparian, open water, floodplain, marsh, pothole, fen.
5. Rare, threatened, or endangered species in the area.
6. Commercially or recreationally important species in the area.
7. Plants that are dominant at the site (e.g., evergreens, deciduous woody plants, scrub or shrub [2-5 ft tall], grasses, crops, submerged vegetation, emergent aquatic vegetation, attached algae, etc.).
8. Vegetation density (dense, patchy, or sparse).
9. Types of invertebrate, fish, amphibians, reptiles, birds, and mammals that are present.
10. Location of fauna at the site; evaluation of whether fauna live solely on the site or migrate through the site; general food and water source preferences.
11. Evidence of stressed vegetation or animals.
12. Types of ecological receptors expected to be present.

Characterizing a site will ultimately help in the selection of potential ecological receptors. This will be critical if further quantitative assessment is warranted. In ecological assessments of any type, the number of potential receptors at any one site can be large and may include plant, invertebrate, and vertebrate species in aquatic, wetland, and terrestrial environments.

When determining if further quantitative assessment is needed at a site, the user must consider whether contaminants at the site have caused a significant decrease in, or extirpation of, ecological receptors at or near the site. Obviously, if the evidence suggests that serious affects such as these have occurred, a quantitative assessment must be conducted. Regardless, reductions in or extirpation of ecological receptors at or near a site must be considered when conducting the qualitative ecological exposure assessment.

A checklist is provided in Figure F2 to help the user determine whether ecological receptors or their habitat are near the site and may be impacted by a contaminant release. If it is determined that ecological receptors are not present at or near the site that could come in contact with released contaminants, and evidence does not suggest that populations of ecological receptors at or near the site have been significantly reduced or extirpated due to site contaminants, then there is no need to proceed to an exposure pathways analysis. In this case, no further action is required and the results should be documented in a CALM report. On the other hand, if ecological receptors are present at or near the site such that they could

potentially come into contact with released contaminants, or if the evidence suggests that populations of ecological receptors have been significantly reduced or extirpated due to the effects of site contaminants, then an exposure pathway analysis should be completed (Figure F3).

2.5 Phase II: Screening for Potential Exposures to Ecological Receptors

A. Discussion

Activities in Phase II should be performed only if it has been determined that ecological receptors are present at or near the site as described in the Phase I checklist (Figure F2), or if evidence suggests that populations of ecological receptors at or near the site have been significantly reduced or extirpated due to contaminants at the site. This section will help determine whether receptors and/or habitat present at or adjacent to a site are at potential risk from contact with a contaminant release on or near a site. A checklist for potential exposure pathways is included in this section to help the user decide whether exposure pathways are complete such that receptors or habitats are potentially at harm (Figure F3). The sections on contaminant source and release and contaminant fate and transport found below are also designed to help determine whether potential exposures to ecological receptors exist.

B. Contaminant Source and Release

The nature and extent of contamination should initially be determined qualitatively. This assessment should include information such as a description of the physical source of the contaminant release (UST, effluent, drums, pipes, etc.) and to what media contaminants were released (water, soil, air).

C. Contaminant Fate and Transport

To determine if the contaminants released are likely to persist on the site, be degraded, or move offsite, information such as the physical properties of the contaminant (water solubility, vapor pressure, density, molecular weight, etc.) should be obtained.

D. Checklist for Potential Exposure Pathways

The checklist for potential exposure pathways (Figure F3) should be used to decide whether exposure pathways are complete such that released contaminants

could contact receptors or habitats. If it is determined that completed exposure pathways exist, or that exposure pathways existed previously that resulted in a significant reduction in, or extirpation of, ecological receptors at or near the site, then further, quantitative evaluations (e.g., tiered ERA) may be needed in order to make scientifically sound management decisions. In this case, the user should consult the appropriate national, regional, and state regulatory agencies for further guidance. If it is determined that released contaminants will not reach receptors or their habitat and the planned remedial actions will not significantly impact ecological receptors or their habitat, then no further ERA action is required other than documentation in the CALM report. Activities in this phase may also help decide if initial response actions are warranted in situations where immediate impacts are suspected.

Table F1. Considerations For Evaluating Known or Suspected Wetland Habitats

• Obvious or designated wetlands present
• Wetlands suspected (e.g., site adjacent to water body, in floodplain, standing water present, dark, wet soils, mud cracks, debris line, water marks, etc.)
• Vegetation present at suspected wetlands (e.g., submerged, emergent, scrub/shrub, wooded, prairie or grassland)
• Size and depth of suspected wetlands
• Source water at suspected wetlands (e.g., river, stream, creek, lake, pond, groundwater, industrial discharge, surface water runoff)
• Known/suspected contaminant inputs to suspected wetlands
• Discharge of water from wetland to river, stream, creek, estuary, groundwater, impoundment
• Natural community classification[1] of any obvious wetlands present
• Observed biota (e.g., waterfowl, deer, rodents, etc.)

Table F2. Considerations For Evaluating Aquatic Habitats

NON-FLOWING (LENTIC)
• Type of water body (e.g., pond, lake)
• Natural or man-made (e.g., lagoon, reservoir, canal, impoundment)
• Size, depth, trophic status of water body
• Nature of bottom (e.g., muddy, rocky, sand, concrete)

NON-FLOWING (LENTIC)
• Uses of water body (e.g., recreation, flood control, drinking water, habitat)
• Source water (e.g., river, stream, groundwater, industrial discharge, surface water runoff)
• Known/suspected contaminant inputs to water body
• Discharge of water to river, stream, creek, groundwater, wetlands impoundment
• Nature of bottom (e.g., muddy, rocky, sand, concrete, etc.)
• Vegetation present (e.g., submerged, emergent, floating)
• Evidence/observations of benthic macroinvertebrates, fish, reptiles, amphibians, birds, mammals
FLOWING (LOTIC)
• Type of water body (e.g., river, stream, brook, creek, intermittent stream, dry wash)
• Natural or man-made (e.g., ditch or other channeled waterway).
• Size, depth, flow rate, and order (e.g. primary, secondary, etc.) of water body
• Bank environment (e.g., vegetated or bare, steep or gradual grade, height, etc.)
• Natural community classification[1] of any obvious wetlands present
• Uses of water body (e.g., recreation, flood control, drinking water, habitat)
• Source water (e.g., river, stream, groundwater, industrial discharge, surface water runoff)
• Known/suspected contaminant inputs to water body
• Discharge of water to river, stream, creek, groundwater, wetlands impoundment
• Nature of bottom (e.g., muddy, rocky, sand, concrete)
• Vegetation present (e.g., submerged, emergent, floating)
• Evidence/observations of benthic macroinvertebrates, fish, herptiles, birds, mammals

Table F3. Considerations For Evaluating Terrestrial Habitats

WOODED
• Percentage of site that is wooded
• Dominant vegetation (e.g., evergreen, deciduous, mixed)
• Predominant tree size at breast height (e.g., <6 inches, 6-12 inches, >12 inches)

Table F3. Considerations For Evaluating Terrestrial Habitats

• Evidence/observations of macroinvertebrates, reptiles or amphibians, birds, mammals
• Natural community classification[1]
SCRUB/SHRUB
• Percentage of site that is scrub/shrub
• Dominant vegetation
• Predominant height of vegetation (e.g., <2 feet, 2-5 feet, >5 feet).
• Characterize density of vegetation (e.g., dense, patchy or sparse).
• Evidence/observations of macroinvertebrates, reptiles, amphibians, birds, mammals
• Natural community classification[1]
GRASSLAND AND AGRICULTURAL AREAS
• Percentage of site that is open (grassed or cropped - no shrubs or trees)
• Dominant vegetation (e.g., grasses, agricultural crops, other forbs)
• Predominant height of vegetation (e.g., <2 feet, 2-5 feet, >5 feet).
• Characterize density of vegetation (e.g., dense, patchy or sparse).
• Evidence/observations of macroinvertebrates, reptiles, amphibians, birds, mammals
• Natural community classification[1]

[1]From *Natural communities of Missouri*, Nelson, Paul, Missouri Natural Areas Committee, Rev. 1987.

Figure F2. Checklist for Potential Receptors and Habitat.

	Yes	No
Are wetlands such as marshes, swamps, or fens directly adjacent to the site?		
Are aquatic habitats such as rivers, lakes, or streams directly adjacent to the site?		
Are forested habitats directly adjacent to the site?		
Are grassland habitats directly adjacent to the site?		
Are there federal or state rare, threatened, or endangered species adjacent to or near the site?		

Are there one or more environmentally sensitive areas (such as those listed in the text box on pg. F6) at, near, or adjacent to the site?		
Are commercially or recreationally important species on, adjacent to or near the site?		
INTERPRETING RESULTS: If the answer to any one question is yes, then go to pathway evaluation (Figure F3). If the answer to all questions is no, then no further ecological assessment is required.		

Figure F3. Checklist of Exposure Pathways.	Yes	No
• Could contaminants reach receptors via groundwater?		
• Can contaminants leach or dissolve to groundwater?		
• Are contaminants mobile in groundwater?		
• Does groundwater discharge into habitats?		
• Could contaminants reach receptors via migration of nonaqueous phase liquids (NAPL)?		
• Is NAPL present at the site?		
• Is NAPL migrating toward receptors?		
• Could NAPL discharge become exposed where receptors are located?		
• Could contaminants reach receptors via runoff?		
• Are contaminants present in surface soils?		
• Can contaminants be leached from or eroded with surface soils?		
• Is there a receptor located down gradient of the potentially leached or eroded surface soil?		
Could contaminants reach receptors via direct contact?		
• Is the receptor located or using the area where the contamination exists?		
• Is the location of the contamination such that the receptor could contact it?		
• Could contaminants reach receptors through inhalation via surface air or burrows?		
• Could the contaminant be volatilized or transported in air as a respirable particulate?		

Figure F3. Checklist of Exposure Pathways.

	Yes	No
• Is the airborne contaminant transported to the receptor?		
Could contaminants reach receptors via ingestion (whether of soil, plants, or animals)?		
• Are contaminants present in soil?		
• Do the contaminants in soil bioaccumulate?		
INTERPRETING RESULTS: If the answer to any one question is yes, then the department may require further assessment. If the answer to all questions is no and the remedial actions will not significantly impact ecological receptors or their habitat, then no further ecological assessment is required.		

3. SCIENTIFIC/MANAGEMENT DECISION POINT (SMDP)

A number of decisions must be made after completion of Phase II of the qualitative ecological exposure assessment that will affect subsequent actions and evaluations. Decisions made by users have been termed scientific/management decision points (SMDP) by U.S. EPA (1994). This nomenclature is adopted in this appendix, although the intent here is not to focus on the legal issues but on the qualitative ecological exposure assessment process.

The SMDP reflects the process by which users have been led to critical decisions including whether a quantitative ERA should be performed. This process envisions an ongoing dialog among interested parties to ensure that the qualitative ecological exposure assessment is on track and that it addresses the technical issues relevant to decision making. All decisions should be documented as the user works through the process.

At the end of a qualitative ecological exposure assessment, the following SMDPs should be considered:

1. Consider an initial response action;
2. Consider no further action;
3. Consider long-term on site management (as explained below).
4. Consider further quantitative evaluation; and/or

4. INITIAL RESPONSE ACTIONS

The need for initial or emergency response actions are usually obvious to an on-site observer. Large volume contaminant releases are possible candidates for emergency action, especially if contaminants are transported to habitat components (e.g., surface water) where receptors may be

exposed. Small volume releases may also require immediate attention if highly toxic compounds are believed to be involved and/or critical habitats or receptors are potentially at risk. Effects attributable to contaminant releases, especially if the effects are widespread and/or likely to be persistent, are reasons to consider emergency actions.

Emergency cleanups are generally conducted without the benefit of detailed studies. If there is no need for emergency action, one should proceed with a qualitative ecological exposure assessment as outlined above. In cases where emergency response actions are warranted, an evaluation of potential risk due to the contaminant release is required after the emergency response actions have been successfully implemented.

5. DETERMINATION OF NO FURTHER ACTION

After the user considers the physical and biological characteristics of the site as shown in Tables F1 through F3, the checklist for potential receptors and habitat in Phase I (Figure F2) should be consulted. If it is determined that ecological receptors are not present at or near the site that could come in contact with released contaminants (answers to all questions in Figure F2 are "NO"), that contaminants at the site have not caused significant reductions in or extirpation of ecological receptors at or near the site, and the proposed remedial actions will not significantly impact ecological receptors or their habitat, then there is no need to proceed to a Phase II exposure pathways analysis. In this case, no further action is required and the results should be documented in a CALM report.

On the other hand, if ecological receptors are present at or near the site such that they could potentially come into contact with released contaminants, or if the evidence suggests that populations of ecological receptors have been signficantly reduced or extirpated due to the effects of contaminants at the site, then a Phase II exposure pathway analysis should be completed (Figure F3).

If it is determined that completed exposure pathways exist such that receptors can potentially contact released contaminants (answers to at least one of the questions in Figure F3 exposure pathways checklist are "YES"), or that contaminants have caused significant reductions in or the extirpation of ecological receptors at or near the site, then further, quantitative evaluations (e.g., tiered ERA) may be needed in order to make scientifically sound management decisions. In this case, the user should consult the department for further guidance.

If it is determined that released contaminants will not reach receptors or their habitat (answers to all of the questions in Figure F3 exposure pathways checklist are "NO," or further site characterization indicates that no exposure pathways exist), and that populations of ecological receptors have not been significantly reduced or extirpated at or near the site due to contaminants

on the site, then no further action is required other than documenting this finding in the CALM report. Activities in this phase may also help decide if initial response actions are warranted in situations where immediate impacts are suspected.

Once the user completes the Phase I and II checklists, the results of the assessment should be considered in context with the CALM initial site assessment, and the user will then proceed into the portion of Figure F1 that lies below the dotted line (outside of the qualitative ecological exposure assessment process).

6. LONG-TERM ON-SITE MANAGEMENT

Long-term management or monitoring may be a useful alternative when considering effective long-term remedial actions at sites where the qualitative ecological exposure assessment indicates that a quantitative ERA is not required or other special circumstances exist. At some sites, the level of risk estimated by the qualitative ecological risk assessment may be minimal, remedial action measures may themselves be environmentally damaging, or the desired technology may not be technically feasible. In such instances, a carefully designed monitoring program for a defined time period, with specific triggers for action, may be a desired alternative.

Monitoring may be most appropriate in cases where there are no continuing contaminant releases and there is no known ecological exposure (i.e., all exposure pathways appear to be incomplete). The monitoring plan should include triggers for additional investigation or action if the monitoring data show that the contamination is increasing or a pathway of ecological exposure is becoming evident. For example, monitoring wells around the perimeter of a site might initially show only background levels of a contaminant. If this remains unchanged, taking no remedial action might be appropriate. On the other hand, increases in contaminant concentrations might indicate either an additional source or the contaminant is moving off-site toward an ecological receptor of concern and so would trigger either investigation or remedial action.

Long-term management or monitoring may not be appropriate for all sites meeting the conditions in Section 5 of this appendix. While the qualitative risk assessment process may suggest that a site poses only minimal risk to ecological receptors, the process does not directly consider the potential risks posed to human beings. Human risk associated with a site is assessed using different, though frequently related, criteria. Furthermore, the absence of ecological receptors does not necessarily indicate that human beings are also absent from the site. On the contrary, the department's experience has been that almost all sites are remediated to facilitate development or redevelopment of a property or simply to remove a known or suspected potential human health hazard. Therefore, the department assumes that sites being assessed through the CALM process will be utilized by at least a human population. Accordingly, the qualitative ecological assessment should be considered as only one part of the overall site assessment and

remedial action planning processes.

7. QUANTITATIVE ECOLOGICAL RISK ASSESSMENTS (ERAs)

A quantitative ERA may be required by the department if:

1. the qualitative ecological exposure assessment indicates that ecological receptors or habitats are likely to be placed at risk by the release;
2. the qualitative ecological exposure assessment indicates that ecological receptors or habitats are likely to be placed at risk by the remedial action at a site;
3. evidence suggests that populations of ecological receptors have been significantly reduced or extirpated due to the effects of contaminants found at the site; and/or
4. a remedial action is proposed to protect ecological receptors or habitats (this is intended to determine the ecological risk of the proposed action).

Depending on site conditions, and the tier at which a quantitative ERA is carried out, the goal of the assessment may be to:

1. determine a maximum concentration of the contaminant(s) of concern which would result in no-effect to the ecological receptor(s);
2. determine a concentration of the contaminant(s) of concern which would result in an effect on the ecological receptor(s) which is deemed acceptable by the department;
3. determine what effect would result from a reasonable maximum exposure of the existing concentrations of contaminants of concern on the ecological receptors;
4. determine what effect would result from an exposure to the 95% upper confidence level of the average concentration of contaminants of concern on the ecological receptors;
5. determine whether a proposed remedial action effectively closes a potential route of exposure; and/or
6. determine whether proposed remedial actions will have an adverse impact on any ecological receptor(s) or habitat(s) (e.g. reduced habitat, disrupted migration pathways, increased siltation, etc.).

In the event remedial action is needed to reduce the risk to ecological receptors, the department must approve the level of remaining risk, if any, prior to the development of a remedial action plan. Furthermore, approval of the Missouri Department of Conservation, Missouri Department of Health, and/or federal agencies with jurisdiction over ecological receptors may also be required.

In the event a proposed remedial action is expected to result in, or not fully address, the risks to ecological receptors such that an adverse impact on ecological receptors is expected after remediation is complete, approval of the remedial action plan may be contingent on payment of a natural resource damage assessment.

The specific protocol for carrying out an ecological risk assessment depends on the identified ecological receptors, indicator species, site characteristics and the assessment goals. Because this is a fairly new and rapidly evolving field of risk assessment, providing a specific framework in this appendix to guide the user through the quantitative ecological risk assessment process is not practical. The user should note that additional site-specific data beyond that required to complete the qualitative ecological exposure assessment will likely need to be collected to conduct a complete quantitative ecological risk assessment. The user should consult the references listed in Section 9 of this appendix and the current literature. The department will evaluate proposals for quantitative risk assessment on a case-by-case basis.

8. ERA REQUIREMENTS FOR THE CALM REPORT

The outcomes of the qualitative ecological exposure assessment and the quantitative ERA (if carried out) must be documented in the CALM report. The report should provide answers to the questions posed in Phases I and II as well as answers to the questions listed in Figures F2 and F3. Other information relevant to the site and contaminant release in question should also be included in the report. Thorough documentation will provide a future reference for any other site-related activities involving a contaminant release, future site remediation, or on-site monitoring.

Refer to section 3.10 of the CALM main body for an explanation of what information is typically provided in the final CALM report.

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USEPA, 1996 is a detailed narrative outline that provides a basis upon which to develop an ecological risk assessment work plan for each site. Users should also note that EPA's intermittent bulletin, *ECO Update*, is periodically published and supplements USEPA OERR (1989). *ECO Update* (available through National Technical Information Service [NTIS]) should be consulted for recent EPA advice and guidance regarding the conduct of ecological risk assessments.